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ORIGINAL RESEARCH

Spatial Distribution and Factors Associated with Multiple Sexual Partnerships among Reproductive-Aged Men in Ethiopia: A Spatial and Mixed-Effect Analysis of the 2016 Ethiopian Demographic and Health Survey

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Background: Though multiple sexual partnerships (MSPs) increase the risk of acquiring sexually transmitted diseases, such as HIV/AIDS, they are still common in sub-Saharan Africa, particularly in Ethiopia. Therefore, this study aimed to investigate spatial distribution and factors associated with MSPs among reproductive-age men in Ethiopia.

Methods: This study was based on Ethiopian Demographic and Health Survey 2016 data. A total weighted sample of 12,688 men aged 15–59 years was included. Spatial analysis was conducted using Arc GIS 10.3 and SaTScan 9.6 statistical software. Mixed-effect logistic regression analysis was used to estimate the association between MSPs and independent variables. Variables with $p<0.05$ on multivariable mixed-effect analysis were considered significant predictors of MSPs.

Results: MSPs had significant variations across the country (global Moran's $I=0.109$, $p<0.001$). The primary-cluster spatial window was located in the southwest Oromia and Somalia regions, withrelative risk of 3 and log-likelihood ratio of 24.49 ($P<0.001$). Age 20–29 years (AOR 2.79, 95% CI 1.83–4.26), 30–39 years (AOR 4.04, 95% CI 2.48–6.58), and 40–59 years (AOR 7.13, 95% CI 4.36–11.68), never married (AOR 1.54, 95% CI 1.13–2.08), femle-headed household (AOR 1.90, 95% CI 1.48–2.44), Internet usage (AOR 1.62, 95% CI 1.21–2.17), ever chewing khat (AOR 1.72, 95% CI 1.37–2.18), ever drinking alcohol (AOR 2.31, 95% CI 1.74–3.08), and being from regions other than Tigray, Harari, and Dire Dawa were significant factors associated with increased odds of MSPs.

Conclusion: MSPs showed significant variations across the country, with the primary-cluster spatial window located in Oromia and Somalia regions. Therefore, special attention should be paid to high-risk regions and groups, particularly those who are unmarried and substance users, to decrease MSPs and their serious consequences, such as HIV and other sexually transmitted infections.

Keywords: multiple sexual partnership, spatial distribution, mixed-effect analysis, Ethiopia

Background

Risky sexual behaviors are defined as any sexual activity (sexual initiation at an early age, having multiple sexual partners, having sex while under the influence of alcohol or drugs, and unprotected sexual behaviors) that put a person at risk of developing sexually transmitted infections (STIs), such HIV.[1–3] A multiple sexual

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partnership (MSP) is defined as having two or more sexual partners, and is a major public-health issue in many countries, especially in sub-Saharan Africa.[4–6] Practicing sex with multiple partners exposes one to an increased risk of acquiring STIs, which may in turn lead inability to conceive/infertility and miscarriage.[4,7–10] In addition, increased numbers of nonmarital sexual partners can result in loss of happiness and other mental health consequences, such as higher rates of anxiety and depression and decreased quality of relationships with family, friends, and the community in general.[11,12] Despite its negative health outcomes, many men nowadays have MSPs. According to a previous study in sub-Saharan Africa, the prevalence of male MSPs ranges up to 29%.[13–15] In Ethiopia, the prevalence of MSPs among reproductive-aged men is 3%–54.1%.[16–18] Evidence has revealed that such factors as education, occupation, age, substance abuse, religion, wealth, media exposure, age at first sexual intercourse, residence, and region are associated with MSPs.[14,15,19–29]

Male MSPs are the leading cause of the spread of HIV in sub-Saharan Africa.[13] Even though having MSPs causes a substantial adverse effect on the health of women and men, spatial distribution and determinants of MSPs remain poorly understood in Africa, particularly in Ethiopia. We concentrate on MSPs in reproductive-aged men in Ethiopia because men have greater involvement and influence in such risky sexual behavior than women, and prevention of MSPs among men will have an appreciable effect on preventing MSPs among women.[30] Therefore, we aimed to investigate spatial distribution and factors associated with MSPs among reproductive-aged men in Ethiopia. Since this study is based on nationally representative data and incorporates spatial analysis, which is important in identifying high-risk areas for MSPs, it will have great advantage in informing policy-makers and governmental and nongovernmental organizations to initiate appropriate interventions.

Methods

Study Area and Period

This study was based on data from the Ethiopian Demographic and Health Survey (EDHS) 2016, which was conducted from January 18 to June 27, 2016. Ethiopia is divided into nine regional states (Tigray, Afar, Amhara, Oromia, Somali, Benishangul-Gumuz, Southern Nations Nationalities and People Region (SNNPR), Gambela, and Harari) and two chartered cities (Addis Ababa and Dire Dawa), and is one of the most populous countries in the Horn of Africa. The regional states aand two chartered cities are further divided into 68 zones, 800 woredas, and around 15,000 kebeles (the lowest administrative unit of Ethiopia). According to Worldometer, the population of Ethiopia is >117 million, of which 49.8% are male.

Study Design and Sampling

The 2016 EDHS was a community-based cross-sectional study and stratified and selected in two stages using 84,915 enumeration areas (EAs) created for the 2007 PHC as a sampling frame. A total of 645 enumeration areas — 202 in urban areas and 443 in rural areas — were selected in the first stage and a fixed number of 28 households per each newly formed cluster were selected in the second stage of selection. All women agedf 15–49 years and all men aged 15–59 years were eligible for the interview.[31] The current study comprised a weighted total sample of 12,688 men aged 15–59 years.

Measurement of Variables

Outcome Variable

An MSP was defined as having two or more sexual partners during the 12 months preceding the survey. This was coded "1" when the respondent mentioned two or more sexual partners and "0" when there was no more than one sexual partner.

Independent Variables

Independent variables were age, educationl, working status, religion, marital status, sex of household head, household wealth, age at first sex, radio and television consumption, Internet use, chawing khat (ever), use of alcohol (ever), ever tested for HIV, ever heard of HIV/AIDS, residence, and region.

Data Management and Analysis

Data extraction, further coding, and analysis were done using Stata 14. Weighting was done to make the data representative, as well as to consider the nonresponse rates and to get appropriate statistical estimates. Since the EDHS has a hierarchical structure and samples were taken using multistage sampling, intra-class correlation coefficient (ICC) was estimated to assess the clustering effect. The ICC revealed that there was a significant clustering effect, and thus we employed mixed-effect logistic regression analysis. Bivariable analysis was done first to screen variables for multivariable analysis, and those variables with $P<0.2$ in the bivariable analysis were considered for multivariable analysis. Model fitness was checked using deviance, and the model with the lowest deviance

Table 1 Sociodemographic characteristics of respondents (n=12,688)

	n	%
Age (years)		
15–19	2,572	20.27
20–29	3,860	30.42
30–39	3,020	23.80
40–59	3,236	25.50
Education		
None	3,840	30.26
Primary	5,901	46.51
Secondary	1,846	14.55
Higher	1,101	8.67
Employment status		
Working	11,737	92.51
Not working	951	7.49
Religion		
Orthodox Christian	5,690	44.84
Muslim	3,985	31.41
Protestant	2,748	21.66
Other	265	2.09
Marital status		
Never married	4,895	38.58
Married	7,471	58.88
Separated/widowed	322	2.54
Wealth		
Poor	4,327	34.10
Middle	2,443	19.25
Rich	5,918	46.64
Sex of household head		
Male	11,122	87.66
Female	1,566	12.34
Age at first sex		
<18 years	5,627	44.35
≥18 years	7,061	55.65
Listen to radio		
Yes	6,477	51.05
No	6,211	48.95
Watch television		
Yes	6,067	47.82
No	6,621	52.18
Internet use		
Yes	1,571	12.38
No	11,117	87.62
Chewing khat (ever)		
Yes	3,418	26.94
No	9,270	73.06
Smoking status		
Smoker	409	3.22
Nonsmoker	12,279	96.78
Alcohol use (ever)		
Yes	5,874	46.30
No	6,814	53.70
Ever been tested for HIV		
Yes	5,797	45.69
No	6,891	54.31
Heard of AIDS		
No	292	2.30
Yes	12,396	97.70
Residence		
Urban	2,501	19.71
Rural	10,187	80.29
Region		
Tigray	795	6.27
Afar	90	0.71
Amhara	3,230	25.46
Oromia	4,758	37.50
Somalia	329	2.59
Benishangul	127	1.00
SNNPR	2,596	20.46
Gambela	37	0.29
Harari	32	0.25
Addis Ababa	621	4.90
Dire Dawa	73	0.57

was considered the best-fit model. Finally, AORs with 95% CIs were calculated, and variables with $P<0.05$ on multivariable mixed-effect analysis were considered significant predictors of MSPs.

Spatial Analysis

Spatial analysis was conducted using Arc GIS 10.3 and SaTScan 9.6 statistical software. Global spatial autocorrelations to ascertain whether MSPs were clustered, dispersed, or random across the country, were calculated using the global Moran *I* statistic.[32] Kriging spatial interpolation was used to predict the magnitude of MSPs in unsampled/unmeasured areas based on the values from sampled measurements. Getis-Ord Gi* statistical hots-pot analysis was used to identify significant hot spots (areas with higher rates of MSPs) and cold spots (areas with lower rates of MSPs).

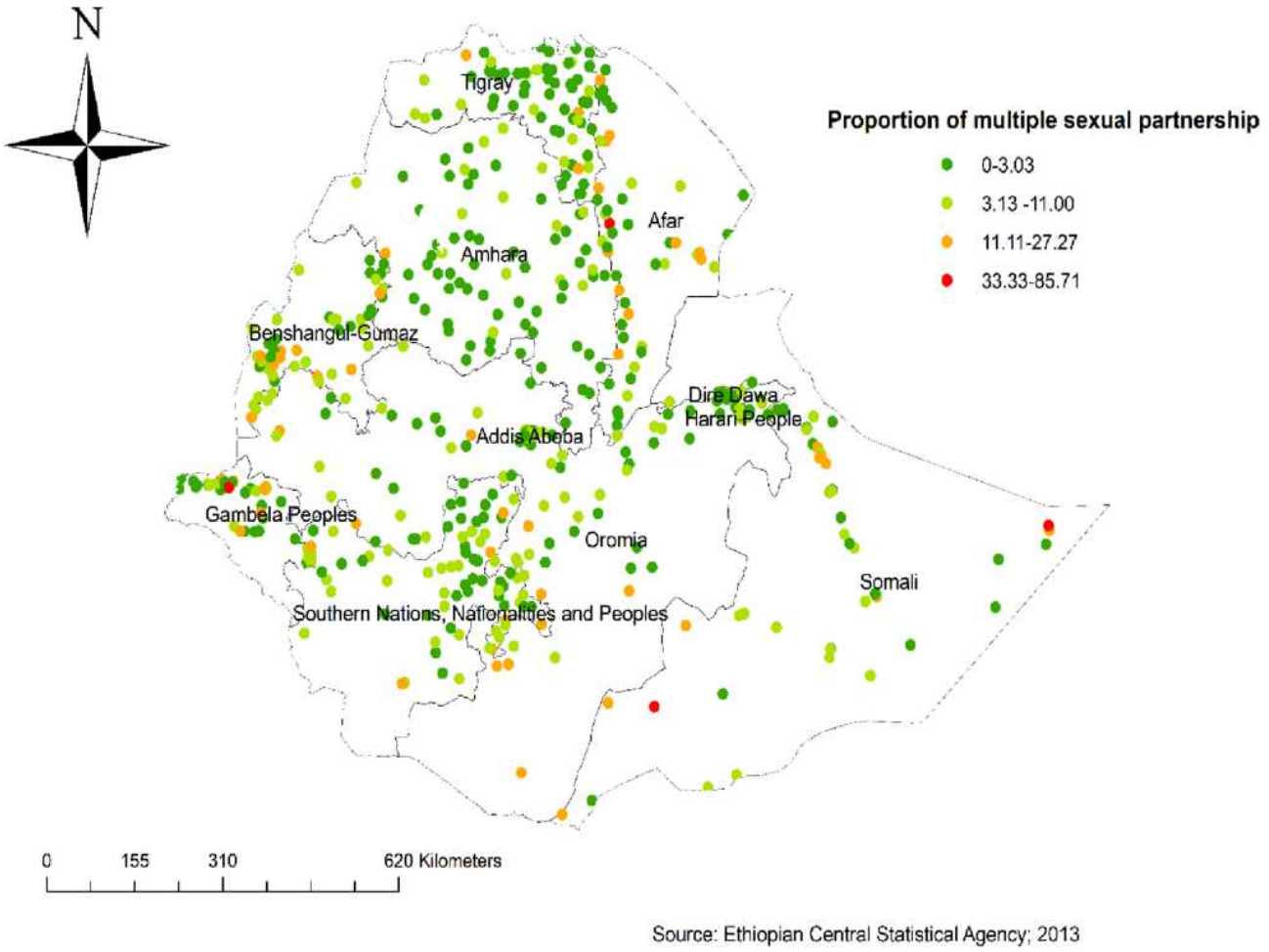

Figure 1 Spatial distribution of MSPs among reproductive-aged men in Ethiopia, 2016.

Since the outcome variable was binary, we used Bernoulli-based spatial scan statistical analysis to detect statistically significant spatial clusters using SaTScan 9.6.[33] To fit the model, men with MSPs were taken as cases and those without MSPs were taken as controls. A default maximum spatial cluster <50% of the population was used as the upper limit for detecting both small and large clusters. Log-likelihood ratios (LLRs) statistic were used to determine if the number of observed cases within the potential cluster was significantly higher than expected or not. Primary and secondary clusters were identified and *P*-values assigned and ranked using LLRs based on 999 Monte Carlo replications. Areas with the highest LLRs and significant *P*-values were considered high-risk areas/clusters, and the spatial window with the highest LLR was defined as the most likely (primary) cluster spatial window.

Results

Sociodemographic Characteristics of Respondents

The mean age of participants were 31±11 years. Most (46.51%) had primary education, and 92.51% had a job. A majority (44.84%) were followers of the Orthodox Christian religion, 58.88% were married, and 87.66% were from male-headed households. A majority (55.65%) had their first sexual intercourse aged ≥18 years, and only 12.38% used the Internet. Less than half (46.30%) had ever drunk alcohol, and 26.94% had a history of chawing khat. More than half (54.31%) had never been tested for HIV, and 97.70% had heard about HIV/AIDS, while 80.29% and 37.50% were from a rural area and Oromia region, respectively (Table 1).

Spatial Analysis of MSPs among Reproductive-Aged Men in Ethiopia

Spatial Distribution

The spatial distribution of MSPs had significant variations across the country (I=0.109, P<0.001). As shown in the green clusters in Figure 1, higher prevalence of MSPs among reproductive-aged men was found in the Afar, Somali, Benishangul, and Gambela regions. Areas with lower MSP prevalence were located in Amhara, Oromia, Harari, Dire Dawa, and Tigray regions, as indicated by red clusters (Figure 1).

Kriging Spatial Interpolation

Based on Kriging interpolation, southwestern Oromia, southwestern and eastern parts of Somalia, and western Afar had higher predicted MSP prevalence. Amhara, Tigray, Dire Dawa, and Harari had lower predicted MSP prevalence (Figure 2).

Hot-Spot and Cold-Spot Analysis

Figure 3 shows regions with red clusters (central Afar, southwest Benishangul, all Gambela, southwest Oromia, and southwest and eastern Somalia) were the significant hot-spot areas. Regions with blue clusters (all Amhara, Tigray, Dire Dawa, and Harari regions) indicate significant cold-spot areas.

SaTScan Analysis

Figure 4 shows the SaTScan analysis. Of the total 622 clusters included, 115 significant clusters were identified. Of these, 27 significant clusters were primary (most likely) and the rest secondary. The primary-cluster spatial window were located in southwest Oromia and Somalia regions with 336.89 km radius and relative risk (RR) of 3, as well as LLR of 24.49 (P<0.001). This can be interpreted as men within the spatial window had three times higher likelihood of MSPs as compared to those outside the spatial

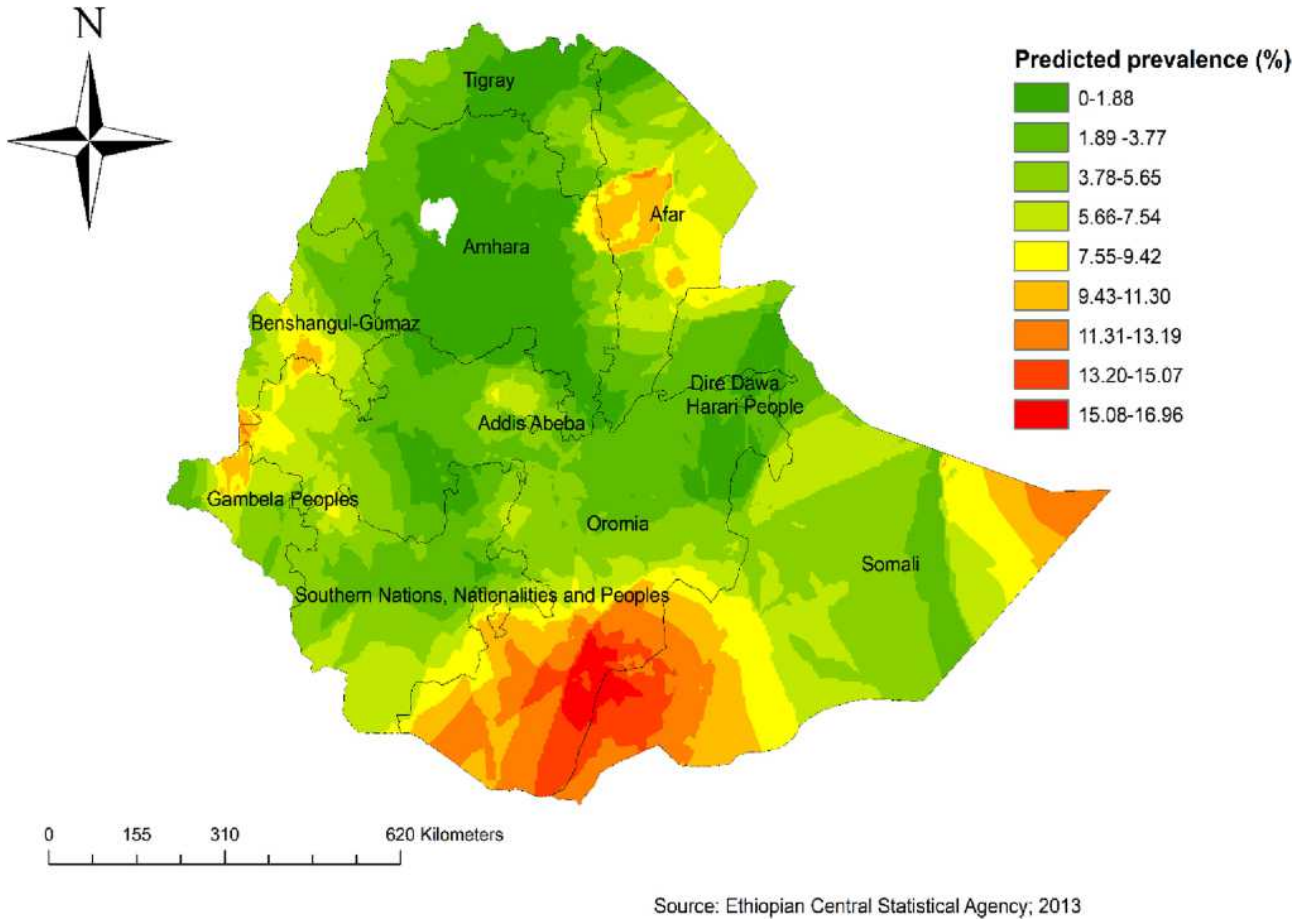

Figure 2 Kriging interpolation of MSPs among reproductive-aged men in Ethiopia, 2016.

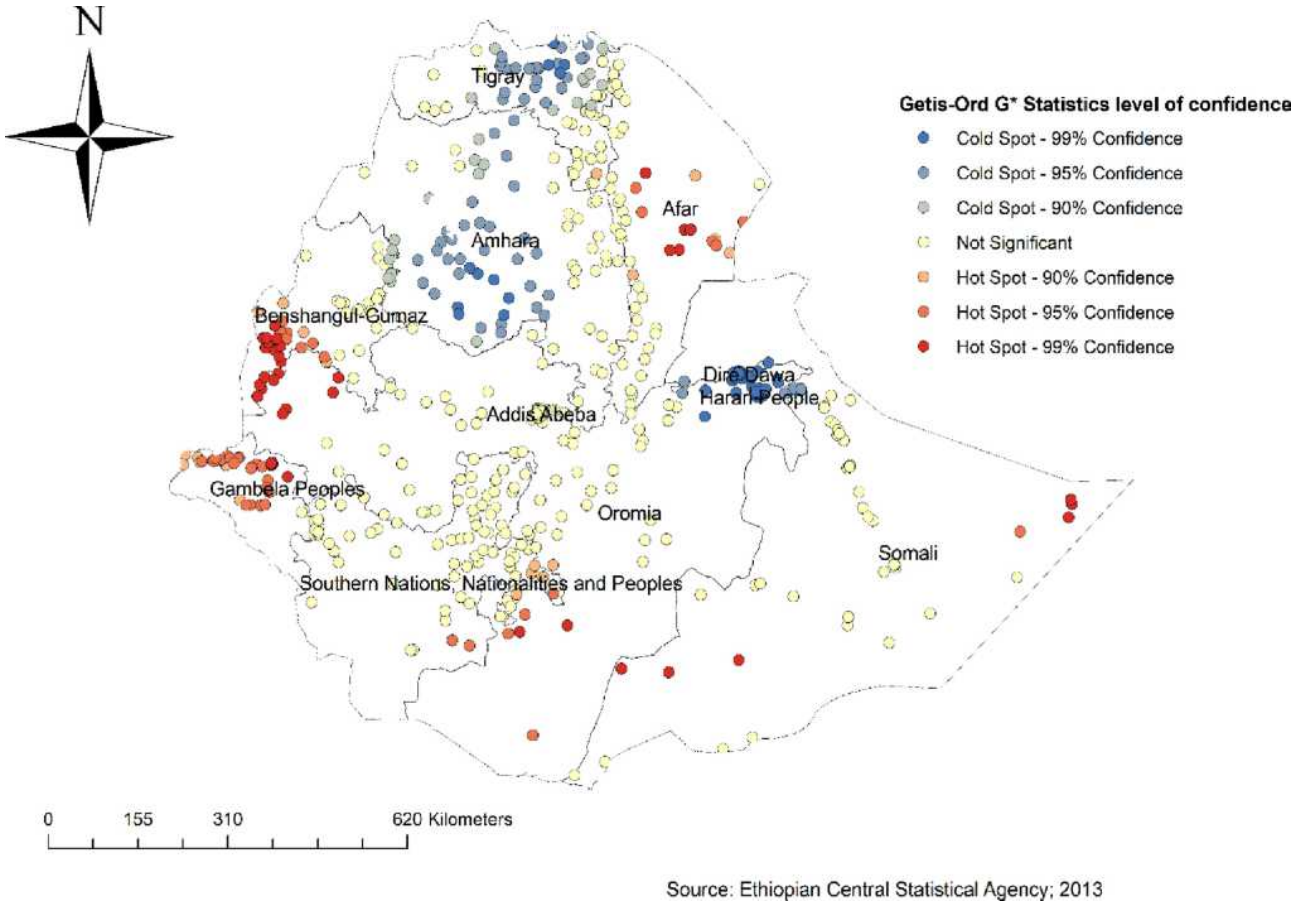

Figure 3 Hot-spot and cold-spot analysis of MSPs in reproductive-aged men in Ethiopia, 2016.

window. The secondary clusters were located in Gambela and Benishangul regions.

Random Effect and Model Fitness

As shown in Table 2, the ICC in the null model (the model containing only the outcome variable) was 0.19, showing about 19% of total variation in MSPs was attributable to differences among clusters/communities. Regarding model fitness, the final model (the model containing both the outcome variable and all independent variables) that had the lowest deviance was the best fit(Table 2).

Factors Associated with MSPs among Reproductive-Aged Men in Ethiopia, 2016

On bivariable analysis, age, occupation, religion, marital status, wealth, sex of household head, age at first sex, listening to the radio, Internet use, ever chewing khat, smoking, ever drinking Alcohol, ever been tested for HIV, residence, and region were associated with MSPs (P<0.20), while on multivariable analysis, age, marital status, sex of household head, Internet use, ever chewing khat, ever drinking Alcohol, and region were significant factors associated with MSPs (P<0.05). The odds of having MSPs were 2.79 (95% CI 1.83–4.26), 4.04 (95% CI 2.48–6.58), and 7.13 (AOR 7.13, 95% CI 4.36–11.68) times among men aged 20–29, 30–39, and 40–59 years than men aged 15–19 years. Never-married men had 1.54 (95% CI 1.13–2.08) times higher odds of having MSPs than married men. Men from female-headed households had 1.90 (95% CI 1.48–2.44) times higher odds of having MSPs as compared to their counterparts. Internet users had 1.62 (95% CI 1.21–2.17) times higher odds of having MSPs as compared to nonusers. Regarding khat and alcohol use, the odds of having MSPs were 1.72 (95% CI 1.37–2.18) and 2.31(AOR 2.31, 95% CI 1.74,3.08) times higher among those who had ever chawed Khat and ever drunk Alcohol, respectivelly, as compared to those who had no such history. In addition, men from regions other than Tigray, Harari, and Dire Dawa had higher

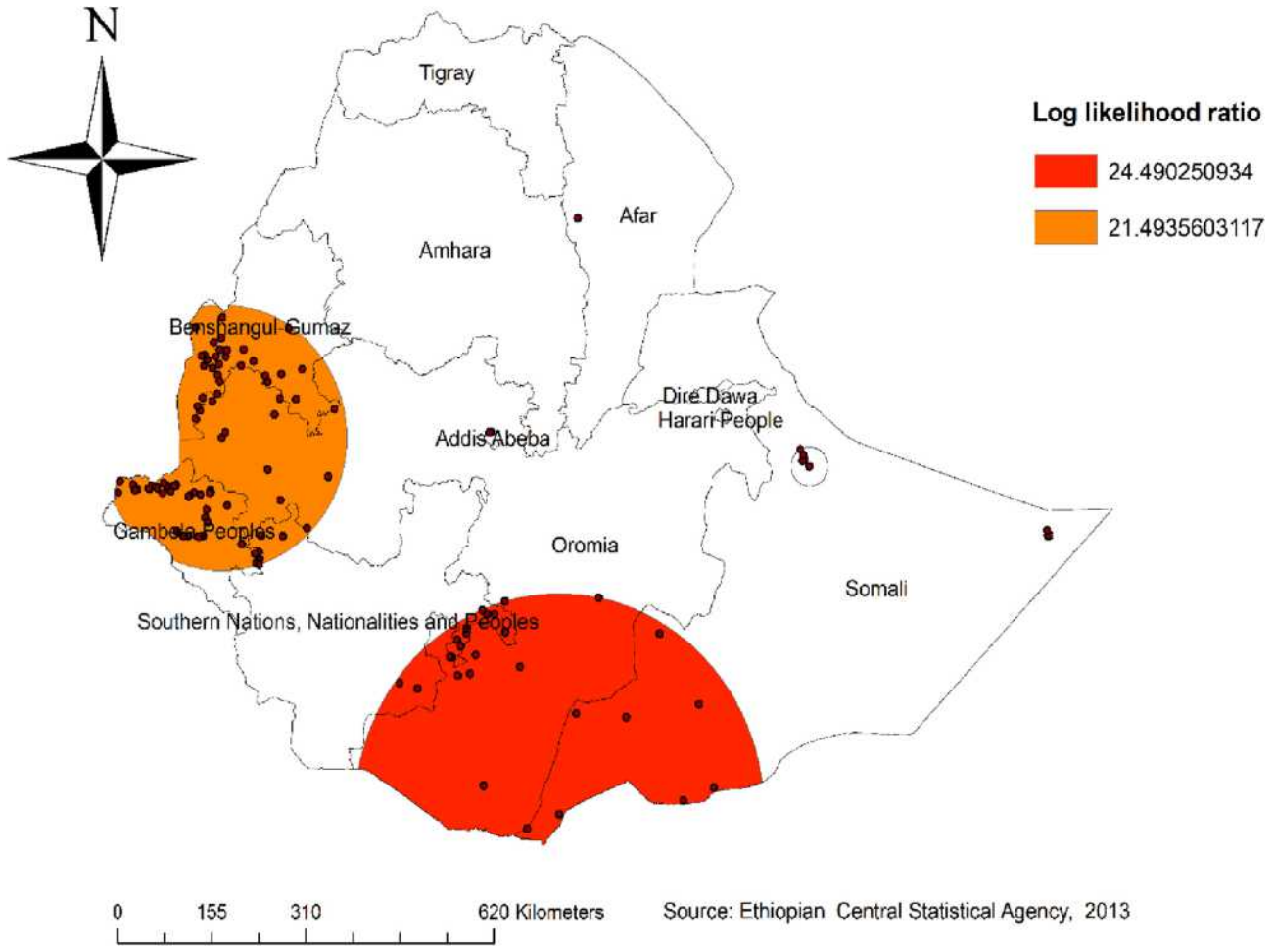

Figure 4 Identified significant SaTScan clusters of areas with higher proportions of men having MSPs in Ethiopia, 2016.

odds of having MSPs than those from the Amhara region (Table 3).

Discussion

In this study, we found that MSPs are not random and had spatial variation in Ethiopia. In the SaTScan analysis, the primary clusters were located in Oromia and Somalia regions with a 336.89 km radius and RR of 3 and LLR 24.49 ($P<0.001$). This regional difference is congruent with a worldwide study that reported huge regional variation in risky sexual behaviors, including having MSPs,[34] and a study in sub-Saharan Africa.[29] Furthermore, this regional variation is supported by this research by the mixed-effect logistic regression analysis, which revealed that these regions were more likely for MSPs. A potential reason is that people's working conditions are harsh and stressful in these border regions. Therefore, these individuals tend to relax and unwind at the end of the day with alcohol and sexual activity.[35] In addition, it may be due to socioeconomic and sociocultural differences among regions.

On the multivariable mixed-effect analysis, age, marital status, sex of household head, Internet, khat, and alcohol use, and region were associated with MSPs among men in Ethiopia. We found that older men had higher odds of having MSPs. This is in line with previous studies,[14,16,25] but contrary to studies conducted in Lesotho and South Africa.[5] This may be due to the greater desire for and familiarity of older men with sex-related activities.

Respondents who had never married had higher odds of having MSPs than those who were married. This is supported by a study conducted in the US.[28] A possible explanation might be that never-married men are vulnerable to experiencing MSPs in the course of seeking an ideal partner. Married men, who are likely to have a safe and settled state of living, avoid risky sexual behaviors

Table 2 Random effect (community-level variability) and model fitness

	Null model	Final model
ICC	0.19 (0.14–0.251)	0.14 (0.10–0.21)
LL	−2,094.22	−1,935.38
Deviance	4,188.44	3,870.76
AIC	4,192.448	3,934.75

Abbreviations: LL, log likelihood; AIC, Akaike information criterion.

like MSPs.[36] Sex of the household head was also an important factor associated with MSPs. The odds of having MSPs were higher for female-headed households, contrary to a study conducted in Lesotho,[14] which revealed that coming from a female-headed household decreased the odds of having MSPs. This may be because the woman participates in MSPs for reasons of economic survival, and this in turn leads to men getting MSPs.

Use of the Internet was a significant factor, ie, respondents who were Internet users were more likely to have MSPs. This finding is in line with studies done in sub-Saharan Africa,[29] Nigeria,[21] and Virginia.[23] In addition, a relationship of online dating via Internet with risky sexual behavior has been reported in studies conducted in Hong Kong and the Netherlands.[37,38] This may be because the widespread accessibility of the Internet can easily promote communication of sensitive issues and sex-related information that allow a person to pursue sexual pleasure. Furthermore, adult men who frequently use the Iinternet are mostly sexually active and may be exposed to pornography, found frequently and increasingly online, and tend to engage in MSPs.[39–41]

Chewing khat was associated with higher odds of having MSPs, and this is supported by studies conducted in sub-Saharan Africa[15] and Ethiopia.[26,27,42] Moreover, drinking alcohol was another important factor associated with increased odds of having MSPs. This finding is also supported by different studies.[15,22,24,27,43–46] This association of alcohol and khat consumption with having MSPs might be due to impaired ability in realizing risks (eg, probability of getting infected with HIV/AIDS and other STIs), in turn increasing risky sexual behaviors, such as having of MSPs.[47]

This study had both strengths and limitations. Since it was cross-sectional study it cannot show a cause-and-effect relationship between having MSPs and exposure variables. In addition, since our outcome variable (MSPs) was assessed based just on the responses of males to the question "How many sex partners including spouse in the last 12 months?", there may have been a social desirability bias. However, this research has value, as it used spatial analysis and identified the most vulnerable areas using SaTScan analysis, as well as using representative national data to inform policy-makers and other governmental and nongovernmental organizations to take concrete action on this public-health problem.

Conclusion

This study revealed that there was a spatial clustering/variation in MSPs among reproductive men in Ethiopia. The primary clusters sptial window were located in Oromia and Somalia regions. Older age, never married, female-headed household, Internet use, khat alcohol consumption, and being from regions other than Tigray, Harari, and Dire Dawa increased the odds of having MSPs. However, being from the Amhara region decreased the odds of having MSPs. Therefore, special attention to high-risk regions and groups identified in this study could decrease MSPs in men and serious consequences, such as HIV and STIs.

Abbreviations

AIC, Akaike information criterion; EDHS, Ethiopian Demographic and Health Survey; ICC, intraclass correlation; LLR, log-likelihood ratio; RR, relative risk.

Data Sharing Statement

We included all result-based data in the manuscript, and the data set can be accessed from www.measuredhs.com/data.

Ethics Approval and Consent to Participate

We accessed the data set from the DHS website (https://dhsprogram.com) through registering or online requests. Ethics approval was not required, since we used publicly available data. This research was exempted by the Institute

Table 3 Bivariable and multivariable mixed-effect logistic regression analysis for factors associated with MSPs among men in Ethiopia, 2016

	MSPs		OR	
	No	**Yes**	**COR (95% CI)**	**AOR (95% CI)**
Age (years)				
15–19	2,552	20	1.00	1.00
20–29	3,741	119	3.03(2.06–4.45)	2.79(1.83–4.26)*
30–39	2,900	120	3.48(2.34–5.16)	4.04(2.48–6.58)*
40–59	3,041	195	5.41(3.70–7.92)	7.13(4.36–11.68)*
Employment status				
Working	938	13	1.92(1.36–2.70)	1.33 (0.91–1.93)
Not working	11,296	441	1.00	1.00
Religion				
Orthodox Christian	5,517	173	1.00	1.00
Muslim	3,824	161	1.34(1.05–1.71)	1.36(0.95–1.97)
Protestant	2,650	98	1.14(0.83–1.55)	1.32(0.91–1.91)
Other	243	22	1.35(0.70–2.60)	1.19(0.60–2.35)
Marital status				
Married	7,135	336	1.00	1.00
Never married	4,786	108	0.65(0.53–0.79)	1.54(1.13–2.08)*
Separated/widowed	313	10	0.86(0.49–1.51)	0.92(0.52–1.63)
Wealth				
Poor	4,165	162	1.00	1.00
Middle	2,358	85	0.90(0.66–1.23)	1.00(0.72–1.38)
Rich	5,710	208	0.86(0.68–1.08)	0.86(0.63–1.16)
Sex of household head				
Male	10,748	374	1.00	1.00
Female	1,485	81	1.51(1.20–1.89)	1.90(1.48–2.44)*
Age at first sex				
<18 years	5,503	124	1.00	1.00
≥18 years	6,731	330	1.58(1.30–1.92)	1.02(0.81–1.29)
Listen to radio				
Yes	6,221	256	1.35(1.11–1.65)	1.22(0.98–1.51)
No	6,013	198	1.00	1.00
Internet use				
Yes	1,505	66	1.31(1.03–1.66)	1.62(1.21–2.17)*
No	10,728	389	1.00	1.00
Chewing khat (ever)				
Yes	3,221	197	2.19(1.79–2.69)	1.72(1.37–2.18)*
No	9,013	257	1.00	1.00
Smoking status				
Smoker	384	25	2.09(1.55–2.83)	1.22(0.89–1.69)
Nonsmoker	11,849	430	1.00	1.00
Alcohol use (ever)				
Yes	5,632	212	1.58(1.27–1.96)	2.31(1.74–3.08)*
No	6,602	242	1.00	1.00

(*Continued*)

Table 3 (Continued).

	MSPs		OR	
	No	**Yes**	**COR (95% CI)**	**AOR (95% CI)**
Ever been tested for HIV				
Yes	5,541	256	1.27(1.05–1.54)	1.11(0.89–1.38)
No	6,693	198	1.00	
Residence				
Urban	2,410	91	1.00	1.00
Rural	9,823	364	1.00(0.77–1.29)	1.23(0.84–1.80)
Region				
Amhara	3,181	49	1.00	1.00
Tigray	776	19	1.89(1.00–3.56)	1.84(0.96–3.52)
Afar	84	6	5.52(3.01–10.13)	7.06(3.58–13.91)*
Oromia	4,546	212	3.81(2.18–6.67)	4.38(2.42–7.98)*
Somalia	310	19	6.11(3.45–10.83)	8.18(4.25–15.74)*
Benishangul	120	7	5.09(2.82–9.10)	5.57(3.01–10.32)*
SNNPR	2,485	111	3.43(1.94–6.07)	4.12(2.21–7.67)*
Gambela	34	3	5.36(2.96–9.79)	5.23(2.73–10.00)*
Harari	29	2	1.82(0.87–3.83)	1.73(0.78–3.86)
Addis Ababa	594	27	4.00(2.23–7.19)	2.61(1.34–5.10)*
Dire Dawa	71	2	2.07(1.05–4.09)	1.81(0.86–3.82)

Note: *$P<0.05$.
Abbreviation: COR, Crude Odds Ratio.

of Public Health College of Medicine and Health Sciences University of Gondar Institutional Review Committee.

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Author Contributions

All authors made a significant contribution to the work reported, whether in conception, study design, execution, acquisition of data, analysis, and interpretation, or all these areas, took part in drafting, revising, or critically reviewing the article, gave final approval to the version to be published, agreed on the journal to which the article has been submitted, and agree to be accountable for all aspects of the work.

Disclosure

The authors declare that they have no competing interests.

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